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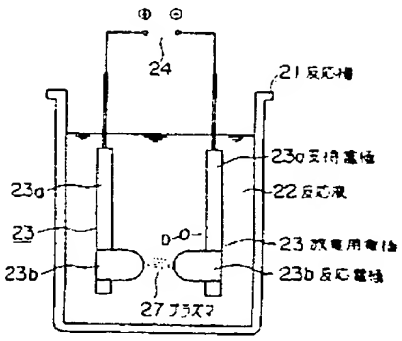
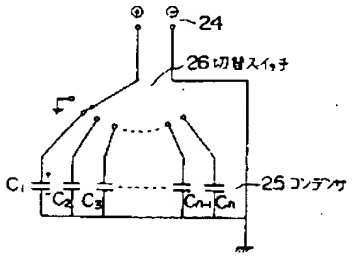
INVENTOR : OMORI TOYOAKI;

INT.CL. : G21B 1/00

TITLE : NUCLEAR FUSION GENERATING DEVICE





ABSTRACT : PURPOSE: To increase a detection amount of neutrons by generating deuterium ions which are generated by applying pulsated voltage to a pair of discharging electrodes and also by causing nuclear fusion reaction by a pressure wave which is generated by underwater electrical discharge.

CONSTITUTION: In a nuclear fusion generating device of this invention, an insulation break-down of a reactive liquid 22 occurs between discharging electrodes 23b when a pulsated voltage is applied to an electro-magnetic terminal 24, consequently an underwater plasma 27 is generated, and electric charge which is accumulated in a capacitor C_1 of capacitors 25, for instance, is reduced by the pulsated electrical discharge. Accompanying this electrical plasma discharge, deuterium ions (nuclei of deuterium D) are generated and also, because a pressure wave by the discharge accompanies, the deuterium nuclei D collide with a surface of a supporting electrode 23a by the pressure, to be trapped there. In this way, a nuclear fusion reaction called D-D reaction, is generated by a reaction with continuously colliding another D. In this case, a production rate of several tens to several hundreds folds, compared to an ordinary method by an electrolysis, can be obtained.

91-129317/18 K05 X14 OMOR/ 08.08.89
OMORI T *J0 3068-894-A
08.08.89-JP-203870 *(25.03.91)* G21b-01

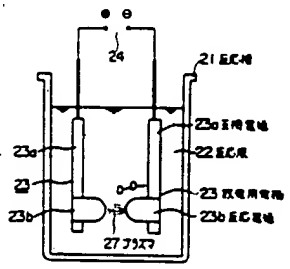
Nuclear fusion generator, for nuclear fusion - comprises reaction tank, paired discharging electrodes and control power source applying pulse voltage, etc.

C91-055914

K(5-A3)

Nuclear fusion generator has: (a) reaction tank filled with reaction soln. using heavy water as reactant; (b) aired discharging electrodes in reaction tank; and (c) control power source supplying pulse voltage at predetermined period to electrodes. Nuclear fusion reaction is generated by generation of heavy water ions generated by applying pulse voltage to electrodes and pressure wave generated by underwater plasma discharge. The electrodes have discharging electrodes and supporting electrodes holding discharging electrodes. Discharging electrodes are formed by high m.pt. metal. Supporting electrodes are formed by high heavy hydrogen adsorptive metal material. Low m.pt. good conductor metal fine wire is fixed to each supporting electrode. Wire is used as discharging starting material melted by plasma discharge.

USE/ADVANTAGE - Used for nuclear fusion. Generation of heavy water ions and pressure wave are used as heavy hydrogen atomic nucleus-heavy water atomic nucleus reaction. Result increases the atomic nucleus-heavy water atomic nucleus section using simple generator. Result obtains high neutron detecting amt. of at least two digits compared to conventional electrodialysis nuclear fusion appts.. (6pp Dwg.No. 1/1)



第1図

neutron plasma under water

includes translation

⑲日本国特許庁(JP)　⑪特許出願公開

⑫公開特許公報(A)　平3-68894

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G 21 B 1/00		Z 9014-2G	

審査請求　未請求　請求項の数 4　(全6頁)

㊹発明の名称　核融合発生装置

㉑特　願　平1-203870
㉒出　願　平1(1989)8月8日

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明　細　書

1．発明の名称

核融合発生装置

2．特許請求の範囲

(1) 重水を反応物質とする反応液を充填した反応槽と、この反応槽内に配設した1対の放電用電極と、この1対の放電用電極にパルス電圧を所定の周期で供給する制御電源とを有し、前記1対の放電用電極に前記パルス電圧を印加して生ずる重水素イオンの発生とさらに水中プラズマ放電によって生ずる圧力波によって核融合反応を起させることを特徴とする核融合発生装置。

(2) 1対の放電用電極は、放電電極とこの放電電極を保持する支持電極を有し、前記放電電極は高融点金属で形成され、前記支持電極は重水素吸着性の強い金属材料で形成されたものであることを特徴とする請求項1記載の核融合発生装置。

(3) 放電電極の近傍の支持電極に懸濁し状に低融点良導体金属の細線を固着し、この細線をプラズマ放電開始時に溶断させる放電起動材としたことを特徴とする請求項1又は2記載の核融合発生装置。

(4) 反応液は電解質を溶解した水と重水との混合液であることを特徴とする請求項1又は2記載の核融合発生装置。

3．発明の詳細な説明

〔産業上の利用分野〕

この発明は核融合発生装置に関し、特に従来の真空と強力磁場による核融合プラズマ閉じ込め方式の熱核反応形核融合炉から脱皮した簡便な新しい核融合発生装置に関するものである。

〔従来の技術〕

従来、大規模集中形エネルギシステムの代表的な未来の新エネルギ技術として永年に渡って核融合が研究されてきた。しかし、トカマク方式と呼ばれる方式をはじめとする核融合炉による熱核融合反応の制御は極限技術や高度なハイテクノロジーの集積があってはじめて可能であり、実用化までにはなお、かなりの期間と莫大な費用を要することが指摘されており、その前途は極く悲観的な

様相を呈するに至っている。

このような情勢下において、最近、1989年3月23日、フイナンシャルタイムズに発表されたフライシュマンとポンズによる成果の報道以来、重水の電気分解による常温核融合の研究が脚光を浴び、前記熱核融合装置とは比較にならない装置の簡便性に対する魅力も手伝って世界的な研究ブームが展開されている状況である。これらの技術内容については新聞等のトピックス記事として成果の肯定・否定面とともにセンセイショナルに報道されている段階であるので、ここではその説明は省略する。なお、上記のような電気分解法では中性子量の収量は1秒間当り0.3個程度である。

ところが、科学朝日（7月号）1898 P.109に掲載された記事によれば、1989年4月下旬になって、イタリア・フラスカッチ研究所のグループが電気分解を使わずに極めて静的な方法で低温核融合を起こさせることに成功したという論文を開示している。

第5図はこの文献に示された実験段階の低温核融合装置の構成説明図である。図において、まず、ステンレス鋼容器1内に100grのチタン2を置き、バルブ4，5を開いて真空ポンプ3で排気する。ついで、バルブ4を閉じてバルブ6を開き重水素ガスボンベ7から徐々に重水素ガスを送り、圧力計8で監視しながら最終的には50気圧まで上げて十分にチタン2に重水素を吸着させる。その後、液体窒素10を充填した冷却タンク9にステンレス鋼容器1を浸し、図示しないバルブ5，6を閉じて温度測定装置で液体窒素温度－196℃での平衡温度に達するまで冷却し、チタン2に重水素ガスが冷却前よりさらに吸着されたことを確認する。さらに吸着が進行したことは圧力がより低下することから知られる。なお、11は図示しない計数装置に接続する中性子検出器であり、ステンレス鋼容器1の脇に配置されている。もしD－D反応（Dは重水素原子核）による核融合が反応したときは、中性子が発生するから中性子検出器11の出力が増大して計数されるようになっている。

以上の構成と状態において、液体窒素が蒸発するにまかせておくとチタン2の温度も徐々に室温に近くなるまでに上昇するが、チタン2の温度が上がってゆく途中で、バックグランドの35倍という多量の中性子が発生したことが観測された。また、この実験法を一寸変えて、重水素を吸わせたチタン2を真空中に置き、同様の実験、すなわち液体窒素温度まで冷却したのち徐々に常温にもどす実験ではさらに収量が増大し、バックグランドの500倍もの中性子発生が測定されたとされている。

上記の実験の結果は、最近話題となった前述の電気分解を行うこともなく、単に重水素ガスの圧力や温度を上げたり下げたりするだけで大量の中性子が発生したことを示すもので、現状では常温はずれの成果というほかなく、その真偽を確めたくなる程の貴重な注目すべき実験結果とみなされるものである。

［発明が解決しようとする課題］

上記のような従来の低温核融合発生装置は、それ以前の熱核融合炉に代わる可能性を有するものとして、現在研究の緒についたばかりの段階にあるものであり、この発明が解決しようとする課題として取上げることには直接関係がない技術であると考えられる。課題として強いていえば、第5図の従来例の成果以外では、電気分解による核融合方法は前述のように中性子の収量が極めて小さいから、さらに出力増大へと検討を重ねてゆく必要があるということが挙げられる。

この発明は上記の点に鑑みてなされたもので、重水の電気分解という従来の手段のみに拘泥することなく、また上記のような温度及び圧力の変化という新しい手段を使用することなく、単に従来の強電実験的な手段のみによって核融合を伴わせる核融合発生装置を提供することを目的とするものである。

［課題を解決するための手段］

この発明に係る核融合発生装置は、重水を反応液として充填した反応槽内に1対の放電用電極を配設し、この1対の放電用電極にパルス高電圧を供給する電源からパルス電圧を印加して生ずる水

中プラズマ放電による重水素イオン（$^{2}_{1}H^{+}$）の発生とその圧力波によって重水素原子核－重水素原子核（D－D）反応の核融合を起こさせるようにしたものである。この場合、具体例として1対の放電用電極は高融点金属の放電電極とこれを保持する水素吸着性のよい金属（例えばチタン）の支持電極とからなるものである。さらに、この放電電極の近傍の支持電極には支持電極間を橋渡しする状態で低融点良導体金属の細線を固着し上記のプラズマ放電開始時の放電起動材を必要に応じて設けることもできる。

また、反応液は通常は重水と水との混合液を用いるが、これに電解質を添加したものを用いてもよい。

〔作　用〕

この発明においては、重水中に1対の放電用電極を配設し、この電極間にパルス高電圧を印加して放電電極間の領域で水中プラズマ放電を起こすようになっている。このプラズマ放電によって重水D_2Oから重水素イオンが発生し、その際生じる圧力波によってこの重水素イオンすなわち重水素核D（$^{2}_{1}H^{+}$）が支持電極面に吸着し、その上に重水素原子核D同志間の衝突（非弾性衝突）反応を起し、よく知られた下記(1)式又は(2)式、あるいは(1),(2)式の同時反応が進行し核融合反応が発生すると考えられる。ここで、Tは三重水素原子核（トリチウム）、nは中性子、pは陽子（水素の原子核）を示す。

$$D + D \rightarrow {}^{3}He + n \quad \cdots (1)$$

$$D + D \rightarrow T + p \quad \cdots (2)$$

これらの反応において、核融合反応が発生したか否かはn又はpを検出することで確認するようになっているが、現状ではnを中性子検出器で計測する方法が採用される。

また、1対の放電用電極の放電電極に高融点金属を用い、支持電極に水素の吸着しやすい例えばチタンやパラジウムなどの金属を用いるので、放電電極が放電によって損傷されないし、支持電極面にDが吸着されて取り込まれ、この部分でD同志の衝突断面積を増大せしめる。

さらに、支持電極間に放電起動材を橋渡しして設けるので、最初の電圧印加によってこの起動材を溶断させたとき反応液中にイオン例えば銀の場合Ag^{+}が多く存在するようになり、引き続いて発生させるパルスプラズマ放電が比較的低電圧で持続するようになる。なお、この点に関連して、重水を反応物質とする反応液中に電解質を添加させた場合は、反応液の電気抵抗が電解質がない場合より低下するので、上述の放電起動材を用いなくても、パルスプラズマ放電の起動が容易となる。

〔実施例〕

第1図はこの発明による核融合発生装置の一実施例を示す模式説明図である。また、第2図は第1図の実施例装置を駆動するパルス電圧発生用の制御電源の一実施例を示す回路図である。

第1図において、反応槽21には重水を反応物質（燃料）とする反応液22が充填されている。反応液22は純重水であることが好ましいが経済性を考慮して通常水で希釈した重水からなるものであってもよく、あるいは電解質を少量溶解した通常水との混合液であってもよい。反応液22中には1対の放電用電極23を所定の間隔をもって対称的に対向するよう配置し、その上部から端子24を取り出して電極間にパルス高電圧を印加するようになっている。1対の放電用電極23はチタンやパラジウム等の水素に対して吸着又は吸蔵性のよい金属からなる支持電極23aと、タングステン，タンタルのような高融点金属からなる放電電極23bとが一体形成により構成されている。一対の放電電極23bが対向する側は球状面体で形成されており、この形状は棒状又は平面状であってもよく限定されないが、できるだけ均質かつ再現性のよい水中プラズマ放電が得られる形状であることが望ましい。この電極間のギャップは約3㎜を基準として配置される。また、反応液22の内又は外にはパルス放電のノイズその他に対して電気シールドの良好な図示しない中性子検出器が配設され、反応生成物の中性子量を計測するようになっている。

制御電源については第2図にみられるように、電極端子24に通常DC 20kV程度の電圧が印加され

るように、C_1～C_nで示される高耐圧コンデンサ25が複数個並列に配置され、正極（＋）側は高耐圧の切替スイッチ26の各端子に接続されており、各コンデンサ25は図示しない充電装置によって充電状態に保たれる。なお、第２図の制御回路はこれに限定されないものである。１対の放電用電極23へ印加されるパルス電圧は切替スイッチ26の正極に接続されたニュートラル端子を回転して切替えることによりコンデンサ25のC_1…C_nに充電された電圧を所定の間隔で周期的に順次印加するようになっている。なお充電電圧は20kVに限定されず、反応液22の水中放電の難易に応じて調整できるようにしておくとよい。

以上のように構成された核融合発生装置において、電極端子24にパルス電圧が印加されると、反応液22の絶縁破壊が放電電極23b間で起こり、水中のプラズマ27が発生して例えばコンデンサ25のC_1に充電された電荷がパルス放電となって消費される。このプラズマ放電に伴って重水素イオン（重水素原子核Ｄ）が発生し、さらに放電による圧力波が付随するので、その圧力によって重水D_2Oが解離して生じた重水素イオンすなわち$^2_1H^+$と記述される正イオン状態の重水素原子核（Ｄ）が支持電極23aの表面に衝突してトラップされる。このようにして引続いて衝突してきたもう一つのＤと反応してＤ－Ｄ反応と呼ばれる前述の式(1)又は式(2)による核融合反応を発生するようになる。このようにして得られた核融合は、前述の中性子検出器により計測した結果、電気分解による従来法による結果が１秒当り0.3個の中性子nを検出していた収量に対して、数10倍～数100倍の収量が得られる。

第３図はこの発明の他の実施例を示す概式説明図である。図において、第１図及び第２図の実施例装置と同一又は相当部分には同じ符号を付し、説明を省略する。第３図に示すように28は放電電極23bの近傍の支持電極23aを横渡し状に連結して設けた細線である。この細線28は銀などの低融点導電体からなる約１mmφの金属線である。その他は第１図の実施例と同一構成である。なお、細線28は放電電極23bに対して対称の位置の上側にも設けてもよい。

第３図に示すような構成において、始めに、電極端子24にパルス高電圧を印加すると、電流は細線28を優先して流れるから、瞬時にしてこの細線が溶断されて、第４図に示すように断線状態の細線28aに示す状態となる。このとき、溶断時のスパーク放電によって反応液22中に図示しないイオン（銀を用いたときはAg^+）が発生し、放電電極23bのギャップ領域はそれまでの状態より導電性のよい状態となる。このため、この状態において第２のパルス電圧が印加されれば放電電極23b間の絶縁破壊による放電はしやすくなり、第１図の場合よりプラズマ放電がおこりやすくなる。すなわち、第１図の場合より低い電圧の印加で放電を起こすようになる。このため、放電電極23bの表面をいためないから電極消耗がなくなる効果を有することがこの実施例の特長である。この効果は、第１図の実施例において、放電電極23bに高融点金属を用いて放電面における溶融損失を防止した効果をさらに助長するものとなっていることはいうまでもない。さらに、前述のように反応液22に電解質を添加して使用するとさらに効果大となる。

なお、上記の実施例においては、いずれも重水を反応物質とする反応液を用いて１対の放電用電極のみを使用して核融合反応を発生する場合について示したが、この手段を従来の電気分解による核融合装置に付加することも同様の効果がある。すなわち、図示は省略するが、従来の電気分解型核融合装置として、正極を白金又は金で形成し、負極をパラジウム又はチタンで形成して、反応液に重水＋金属塩（電解質）を用いた核融合装置において、この正極・負極のギャップ近傍にこの発明による１対の放電用電極を配設して、これによる上述のようなプラズマ放電の圧力波を圧力発生装置として併用するようにして負極面におけるＤ－Ｄ又はＤ－Ｔ反応をさらに促進するようにすることも可能である。

〔発明の効果〕

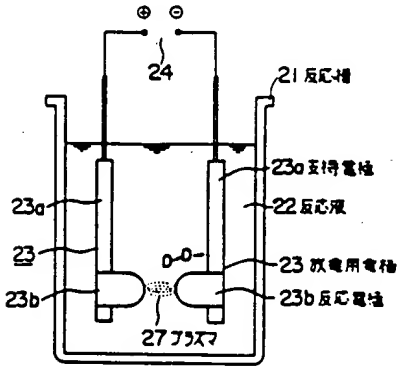
以上のようにこの発明によれば、重水を反応物質とする反応液中に浸漬した1対の放電用電極を配置し、この電極間に起こさせる水中プラズマ放電によって生ずる重水素イオンの発生と放電に付随する圧力波によってD－D核反応を行わせるようにしたので、極めて簡単な装置構成にもかかわらず、D－D反応断面積を著しく増大することができ、従来の電気分解形核融合装置で得られる中性子検出量より2桁以上の高い検出量が得られる。

4．図面の簡単な説明

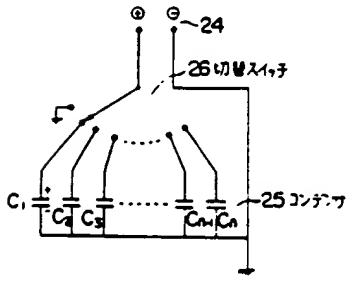
第1図はこの発明による核融合発生装置の一実施例を示す模式説明図、第2図は第1図の装置を駆動する制御電源の回路図、第3図はこの発明の他の実施例を示す模式説明図、第4図は第3図の装置の細線の溶断の状態を示す模式図、第5図は文献に示された低温核融合の実験装置を示す模式図である。

図において、21は反応槽、22は反応液、23は1対の放電用電極、23aは支持電極、23bは放電電極、24は電極端子、25はコンデンサ、26は切替スイッチ、27はプラズマ、28は低融点金属の細線である。

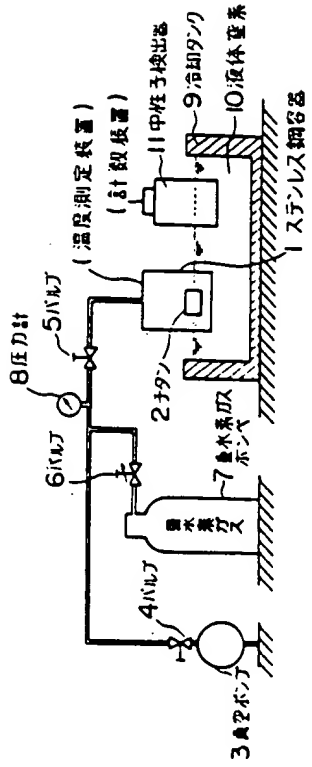
代理人　弁理士　佐々木　宗　治



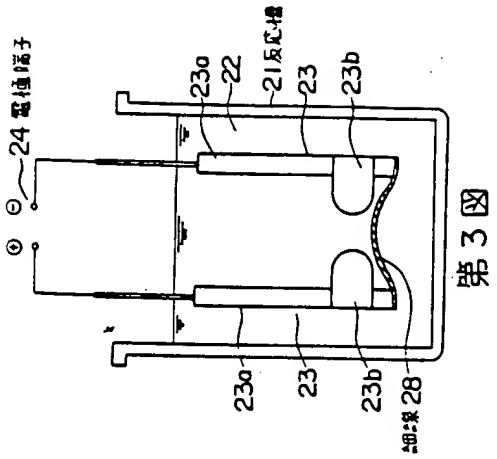
第1図



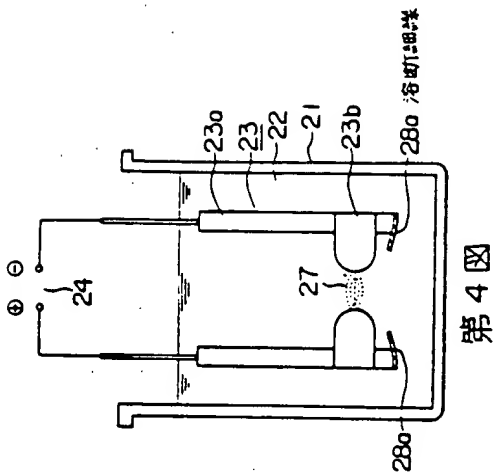
第2図



第5図


24 電極端子
23o
22
21 反応槽
23
23b
23o
23
23b
28 細線

第3図


23o
23
22
21
23b
28o 溶断細線
24
27
28o

第4図

PTO 94-315

Japanese Kokai Patent Application
No. Hei 3[1991]-68894

NUCLEAR FUSION GENERATOR

Toyoaki Omori

UNITED STATES PATENT AND TRADEMARK OFFICE
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Publication Date:	March 25, 1991
No. of Claims:	4 (Total of 6 pages)
Examination Request:	Not requested

NUCLEAR FUSION GENERATOR

[Kakuyugohatsusei sochi]

Inventors: Toyoaki Omori

Applicant: Toyoaki Omori

[There are no amendments to this patent.]

Claims

1. A type of nuclear fusion generator characterized by the following facts: the nuclear fusion generator has a reaction tank

filled with a reactant solution with heavy water used as the reactant, a pair of electrodes for discharge set in the aforementioned reaction tank, and a control power source which provides pulse voltage to the aforementioned pair of electrodes for discharge at the prescribed period; the nuclear fusion reaction takes place due to formation of deuterium ions and the pressure wave caused by the under-water plasma discharge as the aforementioned pulse voltage is applied on the aforementioned pair of electrodes for discharge.

2. The nuclear fusion generator described in Claim 1 characterized by the fact that the aforementioned pair of electrodes for discharge are made of discharging electrodes and supporting electrodes, with the aforementioned discharging electrodes made of high-melting-point metal and with the aforementioned supporting electrodes made of a metallic material with a high deuterium adsorptivity.

3. The nuclear fusion generator described in Claim 1 or 2 characterized by the fact that a fine wire made of a low-melting-point good conductor is fixed in bridge form on the supporting electrode near the discharging electrode, and melting of the fine wire in the initial stage of the plasma discharge acts as a starter for the discharge.

4. The nuclear fusion generator described in Claim 1 or 2 characterized by the fact that the reactant solution is made of a mixture solution of water with electrolyte dissolved in it and heavy water.

Detailed explanation of the invention

Application field in industry

This invention concerns a type of nuclear fusion generator. More specifically, this invention concerns a novel type of nuclear fusion generator with simple configuration different from the conventional thermonuclear fusion reactor using vacuum and a high magnetic field to confine the nuclear fusion plasma.

Prior art

For a long time, research has been performed on the nuclear fusion technology as the future energy source in the form of a large-scale concentrated type energy system. However, for the tokamak program and other nuclear fusion reactors, the thermonuclear fusion reaction can be realized only by using a integration of ultimate [sic] technologies and high-level high technologies, and a long time and a huge investment are needed before they can be used in a practical operation. At present, people are becoming pessimistic to this conventional type of nuclear fusion generator.

Recently, since the report of the results obtained by Flighshman [transliteration] and Vance on March 23, 1989, great interest has been put on the research of the room-temperature nuclear fusion by means of electrolysis of heavy water. As this method has the advantage of simplicity, as compared with the aforementioned conventional nuclear fusion equipment, many research institutions in the world are studying it. There are

nevertheless both positive and negative responses to the results reported for the technical contents in the form of news and special topics. There are also sensational reports appearing in this field. We will not go into detail in this respect. Also, in the aforementioned electrolysis method, the neutron yield is about 0.3/sec.

On the other hand, as reported in a paper on Kagaku Asahi (July issue), 1898, p. 109, it seems that in late April 1989, a group at Frascati Laboratory, Italy, has succeeded in making the low-temperature nuclear fusion using a very static method instead of the electrolysis method.

Figure 5 is a diagram illustrating the configuration of the low-temperature nuclear fusion equipment disclosed in the aforementioned reference. As shown in the figure, 100 g of titanium (2) are set in a stainless steel container (1). Valves (4) and (5) are opened and the container is evacuated by means of a vacuum pump (3). Then, valve (4) is closed and valve (6) is opened, and deuterium gas is fed slowly from a gas cylinder (7). Under monitoring, by means of a pressure gauge (8), the pressure is finally increased to 50 atm, and deuterium is sufficiently adsorbed on the titanium (2). Then, the stainless steel container (1) is dipped in a cooling tank (9) filled with liquid nitrogen (10). After closing valves (5) and (6), not shown in the figure, cooling is performed until the temperature decreases to an equilibrium temperature of -196°C as monitored by a temperature measurement unit. It is confirmed that more deuterium gas is adsorbed on titanium (2) than before the cooling operation. The further adsorption is revealed by the decrease in the pressure. (11) represents a neutron detector connected to a

counter not shown in the figure. It is set on the side of stainless steel container (1). If the nuclear fusion reaction takes place due to the D-D reaction (where D represents the deuterium nuclei), the output of the neutron detector (11) increases and the result is counted.

When the liquid nitrogen continuously evaporates in the aforementioned configuration and conditions, the temperature gradually increases to near the room temperature. During the process of rise in the temperature of the titanium (2), a large amount of neutrons, as many as 35 times the background level, are observed. When the aforementioned experiment is amended a little by setting titanium (2) for adsorption of deuterium in a vacuum, while the same experiment is performed, that is, the system is first cooled to the temperature of liquid nitrogen and then slowly allowed to return to room temperature, the yield of neutrons formed is further increased, and the number of neutrons formed is 500 times that of the background.

The results of the aforementioned experiment indicate that instead of the aforementioned electrolysis method, by simply increasing and decreasing the pressure and temperature of the deuterium gas, a large amount of neutrons can be generated. However, this is outside the present common knowledge, and if it can be confirmed as true, it will become a precious experimental result.

Problems to be solved by the invention

The aforementioned low-temperature nuclear fusion generator may be able to replace the conventional nuclear fusion reactor.

However, at present, it is only in the stage of initial development, and it is believed to be a technology not directly related to the topics to be solved in this invention. What should be taken as the topics include the study on the method to increase the output for the nuclear fusion using the electrolysis method as the yield of neutrons is very low for the conventional scheme shown in Figure 5.

This invention is made in consideration of the aforementioned problems. Instead of being restricted to the conventional method of electrolysis of heavy water, and instead of the aforementioned new method using change in the temperature and pressure, this invention has a purpose in providing a type of nuclear fusion generator which only makes use of the means adopted in the conventional high-voltage experiment to perform the nuclear fusion.

Means for solving the problems

This invention provides a type of nuclear fusion generator characterized by the following facts: the nuclear fusion generator has a reaction tank filled with a reactant solution with heavy water used as the reactant, a pair of electrodes for discharge set in the aforementioned reaction tank, and a power source which provides high pulse voltage to the aforementioned pair of electrodes for discharge; the nuclear fusion of the deuterium nucleus-deuterium nucleus (D-D) reaction takes place due to formation of deuterium ions ($^{2}_{1}H^{+}$) and the pressure wave caused by the under-water plasma discharge as the aforementioned

pulse voltage is applied on the aforementioned pair of electrodes for discharge. In this case, as a specific example, the aforementioned pair of electrodes for discharge may be made of discharging electrodes made of a high-melting-point metal and supporting electrodes made of a metal with high hydrogen adsorptivity (such as titanium). In addition, a fine wire made of a low-melting-point good conductor may be fixed in bridge form between the supporting electrodes near the discharging electrodes, and melting of the fine wire in the initial stage of the plasma discharge acts as a starter for the discharge.

The reactant solution is usually a mixture solution of heavy water and water. However, it is also possible to add an electrolyte in the solution.

Functions

According to this invention, a pair of discharging electrodes are set in heavy water, and under-water plasma discharge takes place in the region between the discharging electrodes as high pulse voltage is applied between these electrodes. In this under-water plasma discharge, deuterium ions are formed from heavy water D_2O; due to the pressure wave generated in this case, the deuterium ions, that is, the deuterium nuclei $D(^2_1H^+)$, are adsorbed on the surface of the supporting electrodes. In this case, collision (inelastic collision) between the deuterium nuclei D takes place, and the nuclear fusion reaction takes place through following formula (1)

or formula (2), or through both formulas (1) and (2). In this case, T represents the tritium nuclei, n represents neutrons, and p represents protons (hydrogen nuclei).

$$D + D \rightarrow {}^{3}He + n \quad (1)$$

$$D + D \rightarrow T + p \quad (2)$$

Whether the nuclear fusion takes place or not in these reactions can be checked by detecting n or p. At present, the plan is to detect n by means of a neutron detector.

As the discharging electrodes of the pair of electrodes for discharge are made of a high-melting-point metal, while the supporting electrodes of the pair of electrodes for discharge are made of a metal with a high hydrogen adsorptivity, such as titanium or palladium, the discharging electrodes are not damaged in the discharge, and D is adsorbed on the supporting electrode surface, where the collision cross-section for D can be increased.

In addition, as a discharge starter material is set as a bridge between the supporting electrodes, when the initial voltage is applied, this starter is melted and many ions, such as ions of silver Ag^{+} when silver is used as the starter, are present in the reactant solution. Consequently, the pulse plasma discharge that takes place afterwards can be maintained under a relatively low voltage. In this respect, as an electrolyte is added into the reactant solution with heavy water used as the reaction substance, the electrical resistance of the reactant solution is lower than that in the case when there is no electrolyte. Consequently, the pulse plasma discharge can take place easily even though there is no starter for the discharge.

Application examples

Figure 1 is a schematic diagram illustrating an application example of the nuclear fusion generator of this invention. Figure 2 is a circuit diagram illustrating an application example of the control power source for generating the pulse voltage for driving the equipment shown in Figure 1.

As shown in Figure 1, reactant solution (22) with heavy water as the reactant (fuel) is filled in a reaction tank (21). Although it is good to have pure heavy water as the reactant solution (22), in consideration of the cost, the reactant solution is usually made of a mixture of water and heavy water, which may be added with a small amount of electrolyte. In the reactant solution (22), a pair of electrodes for discharge (23) are set symmetrically opposite to each other, with terminals (24) set on them for application of high pulse voltage between the electrodes. Said pair of electrodes for discharge (23) have an integrated configuration made of supporting electrodes (23a) made of titanium, palladium or other metal which can adsorb or absorb hydrogen well, and discharging electrodes (23b) made of tungsten, tantalum, or other high-melting-point metal. Said pair of discharging electrodes (23b) are in the form of spherical surface bodies set facing each other. The shape, however, may also be rod or planar, and there is no special limitation in this respect. It is preferred that the shape be appropriate to ensure that the under-water plasma discharge can be realized homogeneously and with a high reproducibility. The gap between the electrodes is set with 3 cm as the standard value. A neutron detector, not shown in the figure, with excellent electrical

shielding to the discharge noise, etc., is set either inside or outside the reactant solution (22). It is used for counting the dose of neutrons as the reaction product.

As shown in Figure 2, for the control power source, C_1-C_n of multiple high-voltage rating capacitor (25) are set parallel to each other for applying a voltage about DC 20 kV on electrode terminals (24). The positive (+) side is connected to the terminal of high-voltage rating switch (26), and each capacitor (25) is kept in a charged state by means of a charging device not shown in the figure. The control circuit is not limited to that shown in Figure 2. The following schemes may also be adopted: The pulse voltage applied on pair of electrodes for discharge (23) is switched by rotating the neutral terminal connected to the positive side of switch (26), and the voltage charged on C_1-C_n of capacitor (25) is applied periodically in sequence with a prescribed period. Also, the charging voltage is not limited to 20 kV, and it can be adjusted appropriately corresponding to the easiness of the under-water plasma discharge in reactant solution (22).

For the nuclear fusion generator with the aforementioned configuration, as the pulse voltage is applied on electrode terminals (24), breakdown of insulation of reactant solution (22) takes place between discharging electrodes (23b), plasma (27) is formed in the water, and the charge in C_1 of capacitor (25) is consumed in the pulse discharge. In accompaniment with this plasma discharge, deuterium ions (deuterium nuclei D) are generated. In addition, as a pressure wave is formed in the discharge, the pressure leads to dissociation of heavy water D_2O

to form deuterium ions $^{2}_{1}H^{+}$. The deuterium nuclei (D) in the ion form, then impact on the surface of the supporting electrode (23a) and are caught. As collisions continue, reaction with another D, that is, D-D reaction, takes place, leading to the nuclear fusion reaction in the form of formula (1) or (2). The nuclear fusion realized in this way is measured by counting the neutrons using the aforementioned neutron detector. It is found that the yield of neutrons is as high as tens to hundreds, as compared to the neutron yield of 0.3/sec obtained in the conventional method using the electrolysis scheme.

Figure 3 is a schematic diagram illustrating another application example of this invention. In this figure, the same or corresponding parts as those in Figures 1 and 2 are represented by the same symbols, and they are not explained again. As shown in Figure 3, (28) represents a fine wire which bridges supporting electrodes (23a) near discharging electrodes (23b). Fine wire (28) is a metal wire with a diameter of about 1 mm and is made of silver or other low-melting-point good conductor. The other configuration features are identical to those in the application example shown in Figure 1. Also, fine wire (28) may be set on the upper side at a position symmetric to discharging electrodes (23b).

In the configuration shown in Figure 3, first of all, a high pulse voltage is applied on electrode terminals (24), and a current flows through the fine wire (28) first. Instantly, this fine wire melts and the fine wire shown in Figure 4 is broken, represented by (28a). In this case, due to the spark discharge in the melting, ions (Ag^{+} when the fine wire is made of silver),

not shown in the figure, are formed in the reactant solution (22), and the gap region of discharge electrodes (23b) becomes highly electroconductive. Consequently, when the second pulse voltage is applied in this state, the discharge can take place easily due to the breakdown of insulation between the discharge electrodes (23b). The plasma discharge in this state can take place easier than in the state shown in Figure 1. That is, the discharge can take place at a lower voltage than that in the case shown in Figure 1. Consequently, there is no consumption of the surface of discharge electrodes (23b) in application example of Figure 1. This effect is a prominent feature of this application example. In addition, the effect can be further increased by adding an electrolyte into the reactant solution (22) as explained in the above.

In the aforementioned application examples, heavy water is used as the reactant, and a pair of electrodes for discharge are set in the reactant solution for the nuclear fusion reaction. This means can also be added to the conventional electrolysis nuclear fusion equipment to realize the same effect as above. That is, in conventional electrolysis type nuclear fusion equipment (not shown in the figure), the anode is made of platinum or gold, while the cathode is made of palladium or titanium, and the reactant solution is prepared from heavy water plus metal salt (the electrolyte). In this nuclear fusion equipment, the pair of electrodes for discharge in this invention may be set near the gap between the anode and cathode, and the pressure liquid [sic; pressure wave] generated in the plasma discharge as explained in the above acts to promote the D-D reaction or D-T reaction at the surface of the cathode.

Effects of the invention

As explained in the above, according to this invention, a pair of electrodes for discharge are set in the reactant solution with heavy water used as the reactant, the under-water plasma discharge generated between the aforementioned electrodes generates deuterium ions and a pressure wave, which perform the D-D nuclear fusion reaction. Although the equipment is very simple, the D-D reaction cross-section can nevertheless be significantly increased, and the detected neutron yield is higher by 2 orders of magnitude than that obtained in the conventional electrolysis type nuclear fusion equipment.

Brief explanation of the figures

Figure 1 is a schematic diagram illustrating an application example of the nuclear fusion generator of this invention. Figure 2 is a diagram illustrating the circuit of the control power source for driving the equipment shown in Figure 1. Figure 3 is a schematic diagram illustrating another application example of this invention. Figure 4 is a schematic diagram illustrating the state of fusion of the fine wire in the equipment shown in Figure 3. Figure 5 is a schematic diagram illustrating the experimental setup of the low-temperature nuclear fusion reported in reference.

21, reaction tank
22, reactant solution
23, pair of electrodes for discharge

23a, supporting electrode

23b, discharging electrode

24, electrode terminal

25, capacitor

26, switch

27, plasma

28, low-melting-point good conductor [fine wire]

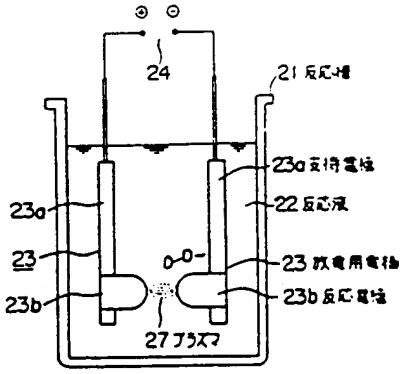

Figure 1

Key: 21 Reaction tank
22 Reactant solution
23 Pair of electrodes for discharge
23a Supporting electrode
23b Discharging electrode

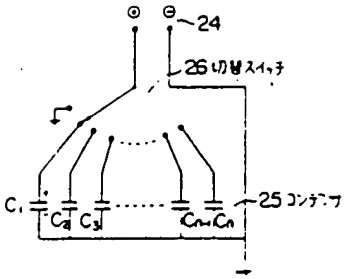

Figure 2

Key: 25 Capacitor
26 Switch

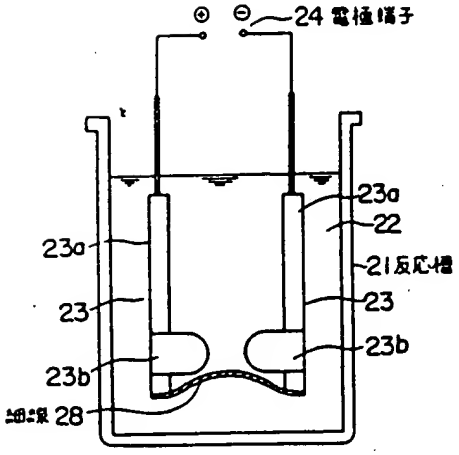

Figure 3

Key: 21 Reaction tank
24 Electrode terminal
28 Low-melting-point good conductor

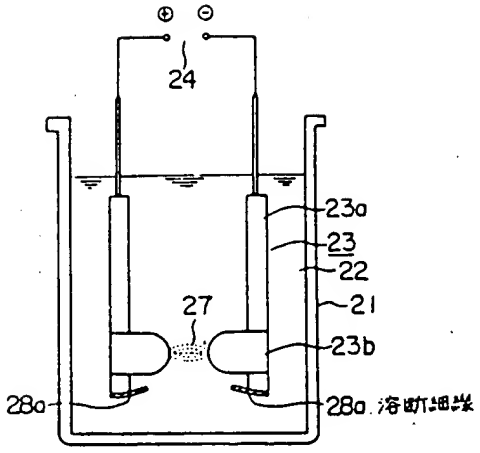

Figure 4

Key: 28a Fused fine wire

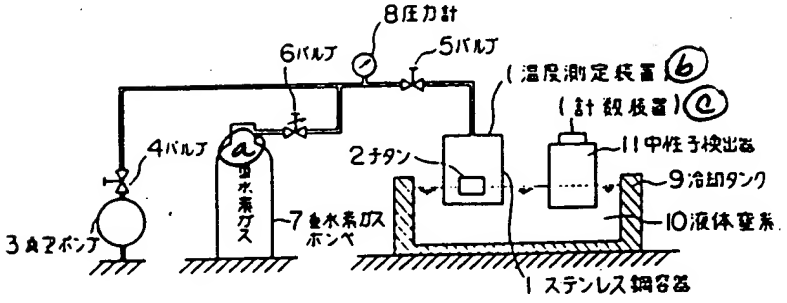

Figure 5

Key:
1 Stainless steel container
2 Titanium
3 Vacuum pump
4 Valve
5 Valve
6 Valve
7 Deuterium gas cylinder
8 Pressure gauge
9 Cooling tank
10 Liquid nitrogen
11 Neutron detector
a Deuterium gas
b Temperature measurement unit
c Counter

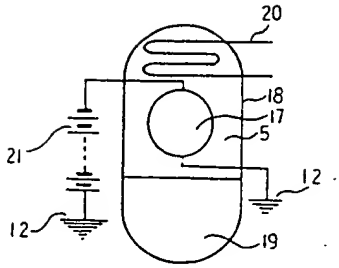

Figure 12